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The Effects of External and Internal Strikes on Total Factor Productivity

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Abstract

This paper examines structural changes that occur in the total factor productivity (TFP) within countries. It is possible that some episodes of high economic growth or economic decline are associated with permanent productivity shocks, therefore, this research has two objectives. The first one is to estimate the structural changes present in TFP for a sample of 81 countries between 1950(60) and 2000. The second one is to identify, whenever possible, episodes in the political and economic history of these countries that may account for the structural breaks in question. The results suggest that about 85% of the TFP time-series present at least one structural break, moreover, at least half the structural changes can be attributed to internal factors, such as independence or a newly adopted constitution, and about 30% to external shocks, such as oil shock or shocks in international interest rates. The majority of the estimated breaks are downwards, indicating that after a break the TFP tends to decrease, implying that institutional rearrangements, external shocks, or internal shocks may be costly and from which it is very difficult to recover.

Keywords: total factor productivity, structural breaks

JEL Classification: O47, O50.

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1 Introduction

One of the main characteristics of modern economies is the large differences in per capita income among countries. Explaining these differences and their evolution over time is an extremely important problem. In a seminal paper Mankiw, Romer, and Weil (1992) investigate the capacity of Solow's growth model to explain the levels of relative variations in per capita income across countries and suggest that the differences can be well described using the augmented Solow model that accounts for accumulation of both physical and human capital. Using structural breaks technique, Ben-David and Papell (1998) proposed a test for determining the significance and the timing of slowdowns in economic growth. They were able to show evidence that most industrialized countries experienced postwar growth slowdowns in the early 1970s, and that developing countries, in particular Latin American countries, tended to experience even more severe slowdowns.

Economists have recognized, however, that total factor productivity (TFP) acts as a determinant factor in the growth process. TFP is usually estimated as a residual using the index number technique.[1] This residual captures changes in the output that cannot be explained by variations in the quantities of inputs, capital and labor. Intuitively, the residual reflects an upward (or downward) shift in the production function. Many factors can cause this shift, such as technological innovation, organizational and institutional changes, demand fluctuations, changes in the factors composition, external shocks, omitted variables and measurement errors.[2]

Hall and Jones (1999), Parente and Prescott (1999), Prescott (1998), Klenow and Rodriguez-Claire (1997), among others, show that there is strong evidence that TFP is considerably responsible for the differences in per capita income across countries. A substantial part of those differences in output levels can only be partially explained by

[1] Different approaches were proposed by Lagos (2006), Parente and Prescott (1999), and Krusell and Rios-Rull (1996). The first study proposes an aggregative model of TFP considering a frictional labor market where production units are subject to idiosyncratic shocks in which jobs are created and destroyed. Therefore, the level of TFP is explicitly shown to depend on the underlying distribution of shocks as well as on all the characteristics of the labor market as summarized by the job-destruction decision. The last two studies propose a theory to explain how institutional arrangements affect TFP, introducing elements of strategic behavior in dynamic general equilibrium models. These studies ultimately try to explain why societies chose these institutions, in an explicit attempt to endogenize this choice.

[2] See Hulten (2001) for a more detailed discussion.

differences in physical capital and education, but the largest part of these differences are explained by the Solow residual, that is, the total factor productivity. Therefore, the difference in capital accumulation, productivity and consequently in output per worker is the outcome of differences in institutions and government policies of each individual country. The institutions and public policies structure existent in each country are defined by the authors as the social infrastructure. Thus, the result points to a strong correlation between output per worker and the social infrastructure indicator, in such a way that countries with public policies that are favorable to productive activities tend to produce more output per worker.

More recently, Jones and Olken (2007) estimated structural breaks for income growth rates and employed growth accounting technique to investigate what occurs during various transitions. Their analysis suggests that changes in the rate of factor accumulation explain relatively little about the growth reversals. Instead, the growth reversals are largely due to shifts in the growth rate of productivity, and reallocations across sectors may be an important mechanism through which these productivity changes take place. Accelerations are coincident with major expansions in international trade, and relatively little change in investment, monetary policy or levels of conflict. Decelerations, on the other hand, are related with much sharper changes in investment, increases in monetary instability, and increases in conflict.

Motivated by the large disparity of economic performance in the medium and long terms across countries and by the argument that differences in total factor productivity are in fact essential to explain these performance differences, this paper examines structural changes that occur in the TFP within countries. It is possible that some episodes of high economic growth or economic decline are associated with permanent productivity shocks, therefore, this research has two objectives. The first one is to estimate the structural changes present in the total factor productivity for a sample of 81 countries between 1950(60) and 2000. The second one is to identify, whenever possible, episodes in the political and economic history of these countries that caused the structural break in question. This paper complements Jones and Olken (2007) and Ben-David and Papell

(1998) by providing evidence of the type of shock that may be triggering the strikes in TFP and so in economic growth.

On the one hand, from the econometrical standpoint, these permanent shocks are represented by an alteration in the parameters of the model, i.e., a structural break. On the other hand, from the economical standpoint, structural breaks may be triggered by external shocks in terms of trade, such as oil shock and shocks in the international interest rates; or internal political-institutional changes such as a newly adopted constitution, the beginning or end of a war, return to democracy, etc. In order to determine the number of structural breaks and the dates in which they occurred, we follow the methodology of estimation and inference proposed by Bai and Perron (1998, 2003). The estimation method considers multiple structural breaks on unknown dates for the linear regression model estimated by the sum of squared residuals minimization, with the advantage that it is possible to control for lags of the dependent variable.

The results suggest that about 85% of the TFP time-series present at least one structural break, moreover, about 53% of the structural changes can be attributed to internal factors, such as independence or a new constitution, and about 29% to external shocks, such as oil shock and international interest rates shocks. Among the 69 countries in which structural changes occurred, 40 had at least one change that can be attributed to internal factors. Most of these countries, about 70%, are developing countries. Therefore, changes in government regimes, political independence or a newly adopted constitution are main factors responsible for structural changes in the TFP series. Two factors are common to various countries, oil shocks and shock in the international interest rates. The oil shock affected particularly the United States and the Western European countries, while, probably due to their financing policy, the Latin American countries were mostly affected by the international interest rates shock. In contrast, the dates of the structural breaks related to the internal dynamics of each country do not show a common pattern. In addition, the majority of the estimated breaks are downward, indicating that after a break the TFP tends to decrease, implying that institutional rearrangements, external shocks, or internal shocks could be costly and very difficult to recover from.

The work is structured as follows. Section 2 presents the methodology used in the construction of the TFP series. Section 3 presents the econometric methodology for estimation and testing. Section 4 presents the results and, finally, Section 5 concludes the paper.

2 Construction of Total Factor Productivity

2.1 Main Assumptions

The total factor productivity time-series for the 81 countries is estimated as residual by using a mincerian production function. The 81 countries are listed in the Appendix. First, we consider the hypothesis used in this calculation.

The Solow neoclassical growth model assumes that there is a technological frontier that grows at a constant rate. This frontier causes the labor productivity to grow continually at this same rate. Therefore, in the long-run equilibrium, not only does labor productivity grow at a constant rate, but also income, capital per worker and output per worker, so as to keep the capital-output relation constant. In this equilibrium where capital, output and worker productivity grow at the same rate, the marginal product of capital, and consequently the market interest rate, remains constant. These characteristics seem to describe the United States during the twentieth century. Therefore, we assume the following:

1) The evolution of the technological frontier is given by the long-run growth rate of output per worker in the United States of America's economy.

2) The growth rate represents, *ceteris paribus*, the evolution of labor productivity of the different economies.

3) The production possibilities of the economies can be represented by a first degree homogeneous aggregated production function of capital and labor.

4) The parameters of the production function and the physical depreciation rate of capital are the same for all economies, with the exception of a multiplier term in the production function which is specific to each country, called Total Factor Productivity.

5) The impact of education on labor productivity is well described by the impact of education on wages. Similarly, the impact of capital on output is well described by the market remuneration of capital.

Hypothesis (1) follows from the observation of the U.S. economy growth path. Hypotheses (2) and (3) are intrinsic to the Solow growth model. Note that hypothesis (4) does not imply that the economies are equal. The assumption is that all existing differences across economies, whether they are institutional, natural resources, etc, imply differences in incentives for factor accumulation. Hypothesis (4) implies that economies respond to variations in factors, *ceteris paribus*, in the same way. An evidence of this fact is that capital share of income does not differ very much across economies, despite their different development levels (Gollin, 2002).

Hypothesis (5), finally, implies that the impact of production factors accumulation, physical or human capital, on output is given by the private impact. If there are any externalities that makes the social benefit of these factors accumulation to be greater than the private benefit, this dislocation will be represented as an elevation of TFP. In addition, the variations of TFP also capture unproductive activities (corruption, crime, etc.), institutional changes (barriers to technology adoption, monopoly power, etc.) and organizational changes at the firm level and those that are specific to each economy which increases (or decreases) the productive efficiency. In addition, TFP, *ceteris paribus*, will be high for economies with high factors endowment.

2.2 Production

Suppose that the aggregate production can be represented by the following production function:

$$y_{jt} = A_{jt} f(k_{jt}, H_{jt}\lambda_t), \tag{1}$$

where y_{it} is the output per worker of economy j at time t. A_{jt} is the total factor productivity, k_{jt} is the capital per labor ratio, H_{jt} represents the impact of education on labor productivity and $\lambda_t = (1+g)^t$ represents the impact of the technological frontier evolution on labor productivity.

Taking the neoclassical model of factor accumulation as baseline, we consider that there is a technological frontier that grows at a rate g. In addition, we assume that the U.S economy presents a path that is close to the balanced growth path of the Solow model. In other words, we assume that all capital accumulation per worker in the American economy from 1950-2000 was caused by increases in labor productivity and, therefore, the capital-labor ratio and the TFP remained constant in this economy. Consequently, in this exercise g will be equal to the annual growth rate of the output per worker in the U.S. economy.

2.3 Education

There is a large amount of literature about returns of human capital accumulation, Ciccone and Peri (2006), Moretti (2004), and Bils and Klenow (2000) investigate the returns of education. Therefore, based on the labor economics literature that investigates the annual returns to education, we assume, according to Bils and Klenow (2000), that:

$$H_{jt} = e^{\phi(h_{it})}, \tag{2}$$

where h_{jt} are the average years of schooling of the economically active population (EAP). The function $\phi(h_{jt})$ is concave, similarly to the results of data for a cross-section of countries (Psacharopoulos, 1994). Bils and Klenow suggest that:

$$\phi(h) = \frac{\theta}{1-\psi} h^{1-\psi}, \tag{3}$$

with $\theta = 0.32$ and $\psi = 0.58$.

2.4 Capital

Another important factor affecting the production function (1) is the capital stock per worker. The capital at time t will be the capital at time $t-1$ depreciated by the physical depreciation rate, added to the investment at time $t-1$, formally written as:

$$K_t = (1-\delta)K_{t-1} + I_{t-1}, \tag{4}$$

where δ is the physical capital depreciation rate, I_{t-1} is the total investment at time $t-1$ and K_t is the aggregated capital stock at time t.

This method requires an initial value to the capital stock, K_0. In order to build K_0 we use the investment of the first years of the sample as a proxy for the investment in previous years. In addition, we assume that the investment grew at a rate given by of technological progress, g, and by population growth, n. Therefore, the total stock of initial capital is given by:

$$K_0 = \frac{I_0}{g+n+ng+\delta}, \tag{5}$$

which is the sum of an infinite geometric progression (details in the appendix), where I_0 is the total initial investment. Usually, we consider I_0 as the average of investment in the first years. We use the first five observations to construct the ratio:

$$\frac{I_0}{L_{1950}} = \frac{1}{5}\left(\frac{I_{1950}}{L_{1950}} + \frac{I_{1951}}{(1+g)L_{1951}} + \frac{I_{1952}}{(1+g)^2 L_{1952}} + \frac{I_{1953}}{(1+g)^3 L_{1953}} + \frac{I_{1954}}{(1+g)^4 L_{1954}}\right), \tag{6}$$

where L_t is the economically active population. A common criticism is that this procedure overestimates the capital stock, because for some countries, the early 1950s was a period of post-war reconstruction and therefore a period in which investment was unusually high. This is the case for the Western European economies. An error in the capital stock causes the initial value of TFP to be underestimated, producing an overestimation for productivity increases after the 1950s. However, with a rate of depreciation at 3.5% per year, after 20 years the estimates are no longer sensible to the initial value of the capital stock. In this way, even if the calculation of the initial capital stock is inaccurate, the evolution of TFP after 1970 is not affected by this issue.

2.5 The Adopted Functional Form

We adopted the Cobb-Douglas (CD) function as a functional form:[3]

$$y = Ak^{\alpha}(H\lambda)^{1-\alpha}, \tag{7}$$

where α is the capital share of income. The CD function implies that the capital-labor substitution elasticity is unitary.

2.6 Data-sets

We investigate the TFP evolution for a set of 81 countries. We use two databases, the Penn World Table (PWT) 6.1 and the Barro and Lee (2000) data-set, where the basic choice criterion was data availability.

The PWT is a database which contains several economic statistics for a large set of countries during the 1950-2000 period. The data for output and investment and the other national account statistics are estimated by controlling for the price variation across economies. That is, the macroeconomic variables are calculated by using an international price index in order to correct systematic variations in the purchasing power across countries.

The data for output is the variable rgdpch#13 from the PWT. The data for economically active population is calculated by dividing the per capita product, rgdpch, by the product per worker, variable rgdpwok#25. For population, we use the POP#3 variable from the PWT. For investment as a share of GPD, we use two variables, ci, for current international prices, and ki, for constant international prices. The ki variable corrects for variations in the relative investment price across economies. As the results are very similar to each other, we report the results obtained by using the constant price series for investment as a share of GDP.

The data for average years of schooling for the EAP was obtained from Barro and Lee (2000). This database contains the years of schooling of the EAP from 1960 to

[3] In order to test the robustness of the results we also use a CES production function to calculate the TFP. Since the results are essentially the same we do not present them.

1999 in five-year intervals. To obtain the values for 1950 to 1959, we did a retroactive extrapolation using the growth rate of the data between 1960 and 1965. For the 1960-1999 period, the data for the missing years was obtained by interpolation.

2.7 Calibration

In order to obtain the TFP estimation as a residual, we will need to calibrate some of the parameters. To calculate K_0, we still need g and δ, as n is calculated for each country using the PWT population data. The calibration for these parameters is described below.

2.7.1 Depreciation

In order to calculate the depreciation rate it is necessary to observe the capital stock. We have this information for the U.S. economy. The American National Income and Product Accounts (NIPA) contain observations for investment by type of durable goods for several years. Given a price curve of the durable goods secondary market for each type of good, it is possible to evaluate the capital stock in monetary units for a given year. In addition, given the capital stock at current prices, the investment at current prices and the implicit product deflator for the U.S. economy, it is possible to calculate the depreciation rate from the following expression:

$$\delta = 1 - \frac{K_{t+1} - I_t}{K_t}. \tag{8}$$

The results are shown in Table 1. We obtain an average depreciation rate of 3.5% per year. Note that in the 1970s the depreciation rate is slightly reduced, which is then compensated by an increase of this rate in the 1980s (the 1970-89 average is 0.018).

Table 1	
Year	Depreciation
1950-59	0.0348
1960-69	0.0398
1970-79	0.0192
1980-89	0.0443
1990-01	0.0365

A possible explanation for the behavior of the depreciation rate during the 1970s and 1980s is that in the 1970s there was a price shock in basic inputs, causing a permanent change in the relative prices. This situation made the current technologies to be no longer be optimal in the long run. Consequently, various investment projects were postponed.

2.7.2 Technological Progress, Population Growth, and Distributional Parameters

We adjust a determinist and continuous trend to the output per worker series for the U.S. economy. We obtain $g = exp(0.0177) - 1$, implying $g = 0.1785$.

We employ the population growth rate for each country between 1950 and 2000 as a *proxy* for the population growth rate n, used in the calculation of the initial capital according to the methodology developed in subsection 2.4, expression (5). The production function is CD, then the capital share of income is constant and given by $\alpha_{K,C}$. We use $\alpha_{K,C} = 0.4$.

2.8 TFP Calculation

Finally, we calculate the productivity for each country based on the following equation:

$$A_{jt} = \frac{y_{jt}}{k_{jt}^{\alpha_{K,C}}(H_{jt}\lambda_t)^{1-\alpha_{K,C}}}$$

for the Cobb-Douglas production function, where A_{jt} is the total factor productivity, y_{jt} is the output per worker of economy j at time t, k_{jt} is the capital-labor ratio, H_{jt} represents the impact of schooling on labor productivity and $\lambda_t = (1+g)^t$ represents the impact of the technological frontier evolution on labor productivity. The construction of the variables and parameters was described in previous sections .

We then calculate the 81 TFP series, and after estimating all the series, we normalize the United States productivity in 1950 as 100. We present some graphics below to illustrate these estimations. The complete series of graphs, with the countries divided by regions, are presented in the Appendix.[4]

3 Econometric Model

We use a dynamic log-linear model to model the TFP time-series for all the countries for which the series are already calculated, and from this model we estimate and test the dates and the number of structural changes present in each series. Lag variables are present in econometrics for several reasons, and when effects of variables persist over time an appropriate model shall include lagged variables. Institution (or TFP) is a variable which is strongly related to its value in previous periods, hence it is important to allow for lags when modeling it. Inclusion of lag variables in the model might be explained for several reasons, for instance, technical and technological reasons may cause delay in implementing changes in capital-labor compositions, institutions are highly correlated with values of preceding periods since implementation of public policies could be very slow, labor contracts are fixed for long periods, etc. Hence, the total factor productivity is modeled as:

$$\ln A_{jt} = C_j + \rho_j \ln A_{jt-1} + \varepsilon_{jt} \tag{9}$$

[4] When investigating closely the graphs of the series by regions, one can notice evidence of club convergence. However, since a formal testing for convergence is out of the scope of the present work, we leave this analysis for future research.

where, A_{jt} is the TFP for the j-th economy at period t, C_j is a constant, and ε_{jt} is the error term, which is assumed to be independent and identically distributed with zero mean and variance σ_j^2.

We assume that there is no change in the autoregression coefficient. Therefore, for instance, in a model with a break in the constant, we have the following model:

$$\begin{aligned} \ln A_{jt} &= C_{j1}^{\tau} + \rho_j \ln A_{jt-1} + \varepsilon_{jt}, \;\; \text{if } t < T_j^* \\ \ln A_{jt} &= C_{j2}^{\tau} + \rho_j \ln A_{jt-1} + \varepsilon_{jt}, \;\; \text{if } t \geq T_j^*, \end{aligned} \tag{10}$$

where T_j^* is the break date for a level change in the j-economy.

For a changes in level and trend, the total factor productivity is modeled as:

$$\ln A_{jt} = C_j + g_j t + \rho_j \ln A_{jt-1} + \varepsilon_{jt}. \tag{11}$$

Thus, if there is a break in the constant and in the time trend:

$$\begin{aligned} \ln A_{jt} &= C_{j1}^{\tau} + g_{j1}^{\tau} t + \rho_j \ln A_{jt-1} + \varepsilon_{jt}, \;\; \text{if } \tau < T_j^* \\ \ln A_{jt} &= C_{j2}^{\tau} + g_{j2}^{\tau} t + \rho_j \ln A_{jt-1} + \varepsilon_{jt}, \;\; \text{if } \tau \geq T_j^*, \end{aligned} \tag{12}$$

where g_j is the linear time trend coefficient and the other parameters have the same meaning as in equation (9).

3.1 Estimation and Inference

The methods used for estimation and testing for the structural breaks in the TFP series were proposed by Bai and Perron (1998, 2003). In this section we describe them briefly. Consider the following regression with m breaks and ($m + 1$ regimes):

$$y_t = x_t'\beta + z_t'\delta_j + u_t \quad \text{ and } \quad (t = T_{j-1} + 1, ..., T_j), \tag{13}$$

for $j = 1,...m+1$. In this model, y_t is the dependent variable observed in time t; $x_t(p \times 1)$ and $z_t(q \times 1)$ are the independent variables, β and δ_j $(j = 1, ..., m+1)$ are the vectors of coefficients; u_t is the error term in time t. The indices $(T_1, ..., T_m)$, or the points of breaks, are treated as unknown, as a convention we set $T_0 = 0$ and $T_{m+1} = T$. The purpose is to estimate the unknown regression coefficients together with the break points when T observations on (y_t, x_t, z_t) are available. This is a partial structural change model, since β is not subject to shifts and is effectively estimated using the entire sample.

The multiple linear regression model (13) can be expressed in the following form:

$$Y = X\beta + \bar{Z}\delta + U, \tag{14}$$

where, $Y = (y_1, ..., y_T)'$, $X = (x_1, ..., x_T)'$, $U = (u_1, ..., u_T)'$, $\delta = (\delta_1', \delta_2', ..., \delta_{m+1}')$, and $\bar{Z}$ is the matrix with diagonally partitions Z at the m-partition $(T_1..., T_m)$, that is, $\bar{Z} = diag(Z_1..., Z_{m+1})$ with $Z_i = (z_{T_{i-1}+1}, ..., z_{T_i})'$. In general, the number of breaks m can be treated as an unknown variable with true value m^0.

The intuition for the estimation is the following: suppose we know the number of structural breaks *ex ante*, or we have an upper bound for it. In the case of one change, for example, we estimate the parameters β and δ by linear regression for all periods in the sample, with the exception of the first and the last ones. Then, we compute the sum of squared residuals. Finally, the estimated break point is the one which minimizes the computed sum of squared residuals. In the case with two breaks we estimate the linear regression for β and δ all combinations (or partitions) with two breaks and compute the sum of squared residuals for each estimate. Again, the estimated break points are the ones which minimize the computed sum of squared residuals. The procedure is the same for larger numbers of breaks.

Formally, for each m-partition $(T_1, ..., T_m)$, denoted $\{T_j\}$, the associated least squares estimates of β and δ_j are obtained by minimizing the sum of squared residuals:

$$(Y - X\beta + \bar{Z}\delta)'(Y - X\beta + \bar{Z}\delta) = \sum_{i=1}^{m+1} \sum_{t=T_{1-1}+1}^{T_i} [y_t - x_t' - z_t'\delta_i]^2 \,. \tag{15}$$

Let $\hat{\beta}$ $(\{T_j\})$ and $\hat{\delta}(\{T_j\})$ denote the resulting estimates based on the m-partitions $(T_1, ..., T_m)$. Substituting them in the objective function and denoting the resulting sum of the squared residuals as $S_T(T_1, ..., T_m)$, the estimated break points $(\hat{T}_1, ..., \hat{T}_m)$ are such that

$$(\hat{T}_1, ..., \hat{T}_m) = argmin_{T_1,...,T_m} S_T(T_1, ..., T_m), \tag{16}$$

where the minimization is taken over all partitions $(T_1, ..., T_m)$ such that $T_i - T_{i-1} \geq q$. Finally, the regression parameters estimates are the associated least squares estimates at the estimated m-partition $\left\{\hat{T}_j\right\}$,that is, $\hat{\beta} = \hat{\beta}$ $(\left\{\hat{T}_j\right\})$, and $\hat{\delta} = \hat{\delta}(\left\{\hat{T}_j\right\})$.

Bai and Perron (1998) propose a test for the null hypothesis of l breaks against the alternative that an additional break exists. Test statistic for testing $H_0 : m = l$ versus $H_1 : m = l + 1$ is constructed using the difference between the sum of squared residuals (SSR) associated with l breaks and those associated with $l+1$ breaks.[5] The test amounts to the application of $(l + 1)$ tests of the null hypothesis of no structural breaks versus the alternative hypothesis of a single change. We conclude for the rejection in favor of a model with $(l + 1)$ breaks if the overall minimum value of the sum of squared residuals (over all segments where an additional break is included) is sufficiently smaller than the sum of squared residuals from the l break model. The break date thus selected is the one associated with this overall minimum. More precisely, the test is defined by the equation:

$$F_T(l + 1 \mid l) = \left\{ S_T\left(\hat{T}_1, ..., \hat{T}_l\right) - \min_{1\leq i\leq l+1} \inf_{\tau\in\Lambda_{i,\eta}} S_T\left(\hat{T}_1, ..., \hat{T}_{i-1}, \tau, \hat{T}_i, ..., \hat{T}_l\right) \right\} / \hat{\sigma}^2, \tag{17}$$

where $\Lambda_{i,\eta} = \left\{\tau; \hat{T}_{i-1} + (\hat{T}_i - \hat{T}_{i-1})\eta \leq \tau \leq \hat{T}_i - (\hat{T}_i - \hat{T}_{i-1})\eta\right\}$ and $\hat{\sigma}^2$ is a consistent estimator of σ^2 under the null hypothesis.

Intuitively, one can reject the model with l breaks in favor of a model with $(l + 1)$ breaks if the minimum SSR (over all segments including an additional break) is sufficiently lower than the SSR of the model with l breaks. Intuitively, $S_T(\hat{T}_1, ..., \hat{T}_l)$ is the SSR under

[5] One drawback in the testing procedure is that the test does not formally allow for time trend regressors. However, we perform a Monte Carlo experiment and the size and power of the test remain unchanged. The Monte Carlo results are available upon request.

the null hypothesis, that is, the SSR of the model adjusted with l breaks and the infimum of $S_T\left(\hat{T}_1, ..., \hat{T}_{i-1}, \tau, \hat{T}_i, ..., \hat{T}_l\right)$ is the lowest SSR considering the model with a additional break, if this additional break is capable of reducing the SSR enough then the test statistic $\sup LR_T(l+1 \mid l)$ increases and one can reject the null hypothesis of l structural breaks. We use the methods of estimation and test described in this section for estimating and testing the number of structural breaks in the TFP for 81 countries.

4 Results

The results for all estimations, which is, all the dates and numbers of structural breaks, are described in Table 3 in the Appendix, as well as possible explanations for the various dates. We allow for a maximum of three breaks, and we use a testing significance level of 5% for all estimations.

There were 109 detectedstructural breaks, with 12 countries showing zero breaks. The Table 2 summarizes the results.

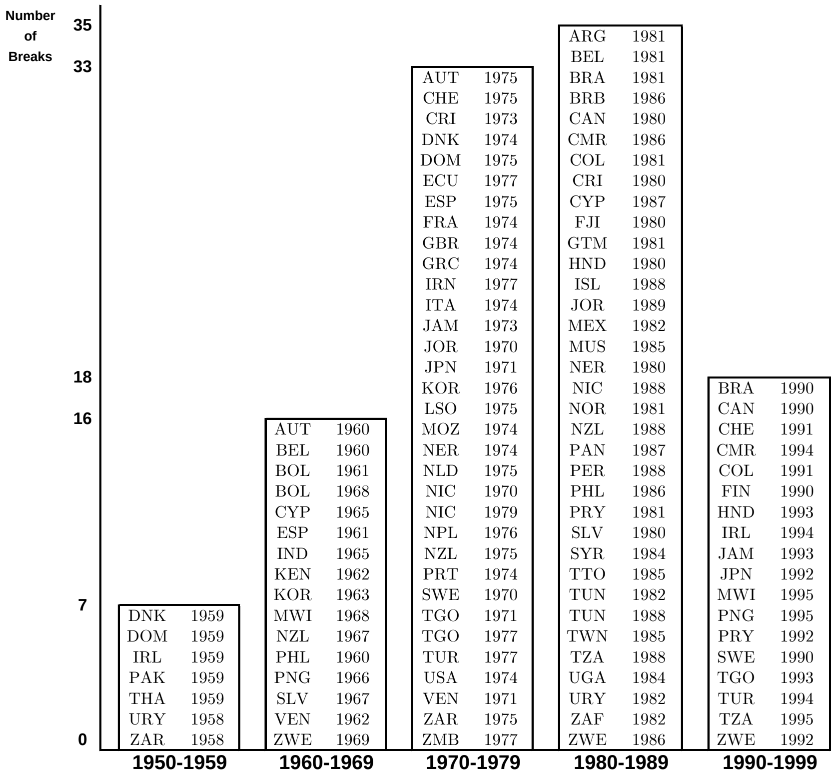
Table 2: selected countries

Number and Percentage of Structural Breaks				
	Zero Breaks	One Break	Two Breaks	Three Breaks
Total de Countries	12	33	32	4
Percentage	14.8	40.7	39.5	4.9

Table 2 shows that about 15% of the countries have zero structural breaks and about 41% of the countries have two breaks[6]. In addition, about 85% of the countries in the sample present at least one structural change. Figure 1 shows histogram with the number of breaks per decade. There are 35 breaks in the 80's and 33 during the 70's. Most of the countries that had structural changes in the 80's are developing countries, and in the 1970-1979 there are a reasonable number of developed countries.

[6] See Table A.1 in the appendix for the country codes.

Figure 1: histogram of number of breaks per decade



In order to interpret the results we have classified the structural changes into two groups. The first group contains the structural changes caused by internal factors. These can be institutional changes, internal political changes such as changes in the constitution, political independence, nationalization of important economic activities, redemocratization, or internal economic changes caused, for instance, by joining a trade block.

In the second group are the structural changes caused by external shocks. These can be described as external economic changes, such as the oil shock in the 1970s and the shock in the international interest rates in the 1980s. About 53% of the structural breaks can be explained by institutional changes. Another 29% of the changes can be explained by external shocks, that is, the oil shock and shock in the international interest rates. The remaining 18% could not be properly explained.[7]

As expected, external shocks affect various countries in a systematic fashion, whereas,

[7] In some cases there is more than one explanation for a break. For example, the break in 1975 in Spain could be associated to the oil shock or a change in constitution in 1978; same happening in Portugal for the estimated break in 1974, which could be explained by the oil shock or by the 1974 revolution and constitution reform in 1976.

in general, the breaks associated with internal dynamics do not show strong regularities across countries. We shall see later that most of the estimated breaks related to internal factors are downwards, with exception of breaks related to trade, implying that internal shocks may have very important consequences for economical development and growth.

Out of the 69 countries that presented structural changes, 40 had at least one change that can be attributed to internal factors. Most of these countries, about 70%, are developing countries. The majority of the breaks were caused by changes in constitutions. Twenty one countries experienced a change in constitution.

As observed by Jones and Olken (2007), economic changes such as trade are important causes of accelerations. However, from all the detected breaks related with internal factors only 8 could possibly be explained by this argument. Therefore, there is evidence that internal political changes are extremely important for explaining breaks in TFP. Examples of countries with changes in constitutions include: Brazil, Canada, Cameroon, Honduras, Nicaragua, New Zealand, El Salvador, and South Africa, among others. Therefore, the results complement Jones and Olken (2007) by giving strong evidence that the majority of the structural changes can be attributed to internal factors, more specifically to institutional and political changes such as political independence or the adoption of new constitution, and therefore, internal shocks are the main factors responsible for structural changes in the TFP series.

Two regularities about the external shocks structural changes were detected. The first observation is that changes caused by the oil shock affected mainly developed countries such as the United States and Western Europe countries like Great Britain, Austria, France, Denmark, etc in the middle of the 1970s. Secondly, various Latin American countries such as Argentina, Brazil, Costa Rica and Mexico, among others, suffered from the shock in the international interest rates during the 1980s. It is likely that the financing policy put in place in response to the oil shock by several Latin American countries set the foundation for future vulnerability to the shock in interest rates. Therefore, the results presented here for TFP are in accordance with the results presented by Ben-David and Papell (1998) for economic growth, since their work argues that while slowdowns in the developed countries are related to the first oil shock, the meltdown for developing countries commenced with the second oil shock and the start of the debt crisis.

Table 3 below presents, for a selected group of countries, the dates and possible explanation of breaks. As previously explained, there are many countries in which productivity was hurt because of the effects of the oil shocks. In some developing countries such as Brasil, Argentina and Costa Rica there are TFP breaks in the early eighties that are, most likely, caused by Volcker's interest rate shock and the financial crises that followed it. As a matter of fact, all but one Latin America country in our sample had at least one productivity break in the eighties or late seventies. And all of them implied productivity reduction or slowdown afterward.

Table 3: selected countries

Countries	Number of Breaks	Dates	Possible Explation	Dates	Possible Explation
ARG	1	1981	Democracy returned 1983; International Interest Rates Shock		
AUT	2	1960	European Free Trade Association	1975	Oil Shock
BEL	2	1960	European Economic Community	1981	
BRA	2	1981	International Interest Rates Shock	1990	Constitution 1988
CAN	2	1980	Oil Shock; April 1982 (Constitutional Action);	1990	1989 US-Canada FTA
CHE	2	1975	Oil Shock	1991	
CRI	2	1973	Oil Shock	1980	International Interest Rates Shock
FRA	1	1974	Oil Shock		
GBR	1	1974	Oil Shock		
JPN	2	1971	Oil Shock	1992	Real State Bubble; Recession
MEX	1	1982	International Interest Rates Shock		
NER	2	1974	Oil Shock	1980	International Interest Rates Shock
USA	1	1974	Oil Shock		
VEN	2	1962	OPEC	1971	Oil Shock; Nationalization

In regards to whether the breaks shift the TFP time series upwards or downwards, we classify the breaks into two categories, say UP and DOWN. The results are shown in Table A.2 in the appendix

UP breaks are those in which the regime after the break is larger than the regime was before.[8] DOWN breaks correspond to the opposite case. Table 3 shows that most of the TFP breaks are DOWN breaks, i.e., about 75% of the breaks (82 out of 109) are downward types of changes, and only about 25% of the changes (27 out of 109) are upward. Upward changes, are strongly related with international trade. For example,

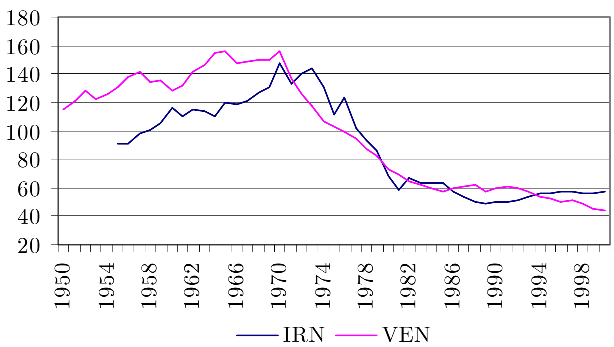
[8]When we consider only a change in the intercept, UP means that the intercept coefficient is higher after the change. For changes in the intercept and slope, UP means that the slope is negative before the break, and positive after the break, or before the break we observe a positive slope, and after the break the slope has a larger positive coefficient (higher coefficient in absolute value).

the estimated structural break in Canada in 1990 could be explained by the US-Canada Free Trade Agreement; the break in 1960 in Belgium and Austria that can possibly be explained by the formation of the European Economic Community and the European Free Trade Association, respectively.

However, the majority of the breaks are downwards. The internal factor changes in government regimes, such as political independence or adopting a new constitutions are the main factors responsible for such structural changes in the TFP series. The majority of these breaks were caused by changes in constitution and among the 21 breaks related with constitutions only 3 are upwards, say Cameroon, Cyprus, and Malawi. In many cases, this is so because new constitutions are adopted after revolutions or periods of civil unrest, and these episodes, in general, impact production and productivity negatively.

From the external factor point of view all the estimated breaks are downwards, with the exception of Switzerland showing an upward break in 1975 which could be related to the oil shock. Therefore, overall, after the changes caused by the oil shock, the productivity declines, since most countries are consumers of this product. However, in our sample there are also countries that are oil producers and for these countries the productivity should increase in the case of a positive terms-of-trade shock. Yet, there are two cases we should analyze individually, Venezuela and Iran. Both countries are oil producers and exhibit structural breaks related to the oil shock in the 1970s, nevertheless their productivities decline sharply after this shock.

Figure 2: TFP Venezuela and Iran



A possible interpretation for the phenomena occurring after adopting a new constitution or that resulted in productivity decline for Iran and Venezuela is given by Rodrik (1999) by arguing that social conflicts might explain the great drop in the TFP of these countries. This result indicates that after a break, the TFP tends to decrease, implying that institutional rearrangements, external shocks, or internal shocks could be costly and difficult to recover from. Another possible interpretation, in the case of Venezuela, can be found in Cole, Ohanian, Riascos and Schmitz (2005), that show that after the nationalization of oil and mining in the seventies, productivity dropped significantly[9].

5 Final Considerations

The purpose of this work is to present estimates for structural breaks in total factor productivity within countries, and to identify, whenever possible, episodes in the political and economic history of these countries that may explain the structural breaks in question. The results suggest that about 85% of the countries in a sample of 81 countries experienced at least one structural change, totaling 109 observed breaks. Among these, about 53% are associated with internal shocks, 29% are associated with external shocks and the other 18% could not be appropriately explained.

The structural changes occur mainly due to internal factors. Changes in government regimes, political independence or the adoption of a new Constitution are responsible for structural changes in the TFP series. Out of 69 countries with structural changes, 40 exhibit at least one break related to internal factors, and most of these breaks occurred in developing countries. In addition, the most common internal factor triggering structural breaks is a new constitution.

Two factors are common to various countries, the oil shock and the shock in international interest rates, causing structural breaks in various economies. The oil shock affected particularly the United States and the Western European countries, while, probably due to their financing policies, the Latin American countries were mostly affected

[9] As for Iran, the Islamic Revolution of 1979 must had played an important role in the productivity break.

by the international interest rates shock. On the other hand, the dates of the structural breaks related to the internal dynamics of each country do not show a common pattern. In addition, the results indicate that the majority of the breaks are downward, and after a break the TFP tends to decrease, implying that institutional rearrangements, external shocks, or internal shocks in general could be costly and difficult to recover from.

6 References

Bai, J.and Perron, P. (1998) "Estimating and Testing Linear Models with Multiple Structural Changes", *Econometrica*, 66, 47-78.

Bai, J. and Perron, P. (2003) "Computation and Analysis of Multiple Structural Break Models," *Journal of Applied Econometrics*, 18, 1-22.

Barro, R. and Lee, J. W. (2000) "International Data on Educational Attainment: Updates and Implications," NBER Working Paper #7911.

Ben-David, D. and Papell, D. H. (1998) "Slowdowns and Meltdowns: Postwar Growth Evidence from 74 Countries," *The Review of Economics and Statistics,* 80, 561-571.

Bils, M. and Klenow, P. (2000) "Does Schooling Cause Growth?", *American Economic Review,* 90, 1160-1183.

Ciccone, A. and Peri, G. (2006) "Identifying Human Capital Externalities: Theory with Applications," *Review of Economic Studies*, 73, 381-412.

Cole, H. L., Ohanian, L. E., Riascos, A. and Schmitz, J., (2005). "Latin America in the rearview mirror," *Journal of Monetary Economics*, 52, 69-107.

Gollin, D. (2002) "Getting Income Share Right", *Journal of Political Economy*, 110, 458-474.

Hulten, Charles. R. (2001) "Total Factor Productivity: A Short Biography", in *New Developments in Productivity Analysis*, Charles R. Hulten, Edwin R. Dean, and Michael J. Harper, eds., Studies in Income and Wealth, vol. 63, The University of Chicago Press for the National Bureau of Economic Research, Chicago, 1-47.

Hall, R. and Jones, C. (1999) "Why Do Some Countries Produce so Much More

Output per Worker than Others?" *Quarterly Journal of Economics*, February, 114, 83-116.

Jones, B. and Olken, B. (2007) "The Anatomy of Start-Stop Growth," *The Review of Economics and Statistics*, forthcoming.

Klenow, P. and Rodriguez-Clare, A. (1997) "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?" *NBER Macroeconomics Annual 1997*, B. Bernanke and J. Rotemberg ed., Cambridge, MA: MIT Press, 73-102

Krusell, P. and Rios-Rull, J. V. (1996) "Vested Interests in a Positive Theory of Stagnation and Growth", *The Review of Economic Studies*, April , 63, 301-329.

Lagos, R. (2006) "A Model of TFP," *Review of Economics Studies*, 73, 983-1007.

Mankiw, G., Romer, D. and Weil, D. (1992) "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, 107, 407-437.

Moretti, E. (2004) "Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data ," *Journal of Econometrics*, 121, 175-212.

Parente, S. L. and Prescott, E. (1999) "Monopoly Rights: A Barrier to Riches" *The American Economic Review*, 89, 1216-1233.

Pessoa, S. A., Pessoa, S. M. and Rob, R.(2003). "Price Elasticity of Investiment: a Panel Data Approach", University of Pennsylvania, (mimeo).

Prescott, E. (1998) "Lawrence R. Klein Lecture 1997 Needed: A Theory of Total Factor Productivity", *International Economic Review*, 39, 525-551.

Psacharopoulos, G. (1994) "Returns to Investiment in Education: A Global Update", *World Development*, 22, 1325-1343.

Rodrik, D. (1999) "Where Did All The Growth Go? External Shocks, Social Conflict, and Growth Collapses"*Journal of Economic Growth*, 4, 385-412.

7 Appendix

Table A.1: Legend

1	ARG	Argentina	41	KEN	Kenya
2	AUS	Australia	42	KOR	Korea, Republic of
3	AUT	Austria	43	LSO	Lesotho
4	BEL	Belgium	44	MEX	Mexico
5	BGD	Bangladesh	45	MOZ	Mozambique
6	BOL	Bolivia	46	MUS	Mauritius
7	BRA	Brazil	47	MWI	Malawi
8	BRB	Barbados	48	MYS	Malaysia
9	BWA	Botswana	49	NER	Niger
10	CAF	Central African Republic	50	NIC	Nicaragua
11	CAN	Canada	51	NLD	Netherlands
12	CHE	Switzerland	52	NOR	Norway
13	CHL	Chile	53	NPL	Nepal
14	CMR	Cameroon	54	NZL	New Zealand
15	COL	Colombia	55	PAK	Pakistan
16	CRI	Costa Rica	56	PAN	Panama
17	CYP	Cyprus	57	PER	Peru
18	DNK	Denmark	58	PHL	Philippines
19	DOM	Dominican Republic	59	PNG	Papua New Guinea
20	ECU	Ecuador	60	PRT	Portugal
21	ESP	Spain	61	PRY	Paraguay
22	FIN	Finland	62	SEN	Senegal
23	FJI	Fiji	63	SGP	Singapore
24	FRA	France	64	SLV	El Salvador
25	GBR	United Kingdom	65	SWE	Sweden
26	GHA	Ghana	66	SYR	Syria
27	GRC	Greece	67	TGO	Togo
28	GTM	Guatemala	68	THA	Thailand
29	GUY	Guyana	69	TTO	Trinidad &Tobago
30	HKG	Hong Kong	70	TUN	Tunisia
31	HND	Honduras	71	TUR	Turkey
32	IND	India	72	TWN	Taiwan
33	IRL	Ireland	73	TZA	Tanzania
34	IRN	Iran	74	UGA	Uganda
35	ISL	Iceland	75	URY	Uruguay
36	ISR	Israel	76	USA	USA
37	ITA	Italy	77	VEN	Venezuela
38	JAM	Jamaica	78	ZAF	South Africa
39	JOR	Jordan	79	ZAR	Congo, Dem. Rep.
40	JPN	Japan	80	ZMB	Zambia
			81	ZWE	Zimbabwe

7.1 K_0

Starting from the capital law of motion:

$$K_0 = (1-\delta)K_{-1} + I_{-1},$$

and

$$K_{-1} = (1-\delta)K_{-2} + I_{-2},$$

substituting

$$\begin{aligned}
K_0 &= (1-\delta)\left[(1-\delta)K_{-2} + I_{-2}\right] + I_{-1} \\
&= (1-\delta)^2 K_{-2} + (1-\delta)I_{-2} + I_{-1} \\
&= (1-\delta)^2\left[(1-\delta)K_{-3} + I_{-3}\right] + (1-\delta)I_{-2} + I_{-1} \\
&= (1-\delta)^3 K_{-3} + (1-\delta)^2 I_{-3} + (1-\delta)I_{-2} + I_{-1} \\
&= \ldots \\
&= (1-\delta)^T K_{-T} + \sum_{j=1}^{T}(1-\delta)^{j-1} I_{-j}
\end{aligned}$$

and assuming,

$$I_{-j} = I_0(1+g)^{-j}(1+n)^{-j},$$

then

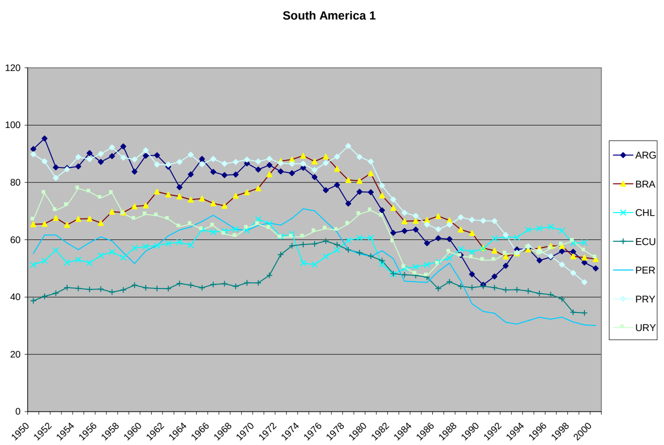
$$K_0 = (1-\delta)^T K_{-T} + \frac{I_0}{(1+g)(1+n)}\sum_{j=0}^{T-1}\left[\frac{1-\delta}{(1+g)(1+n)}\right]^j$$

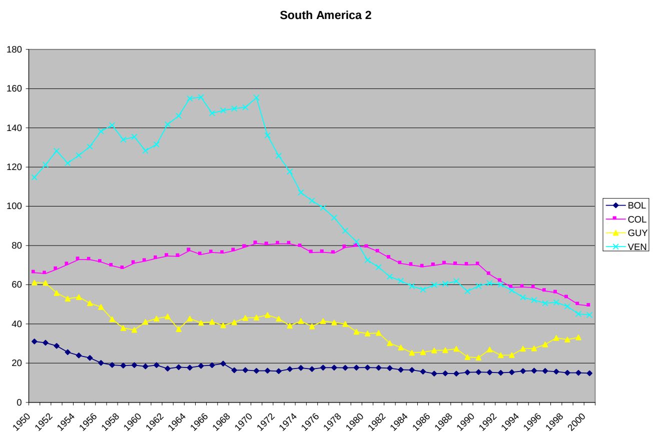
Notice that $(1-\delta) < (1+g)(1+n)$, and taking the limit of the last equation:

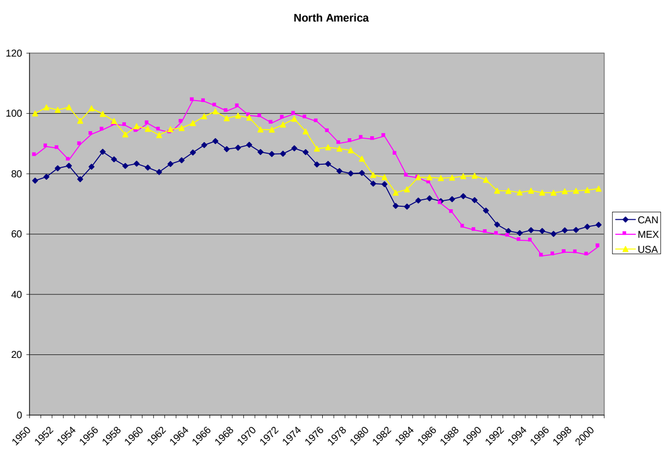
$$K_0 = \frac{I_0}{(1+g)(1+n)}\frac{1}{1-\frac{1-\delta}{(1+g)(1+n)}}$$

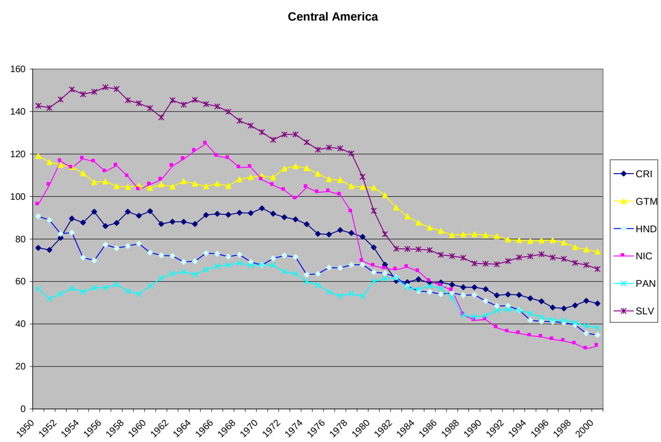
$$K_0 = \frac{I_0}{g+n+ng+\delta}$$

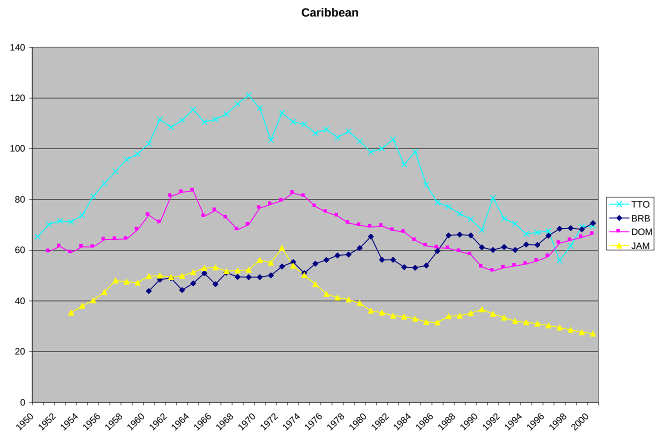
7.2 Graphs







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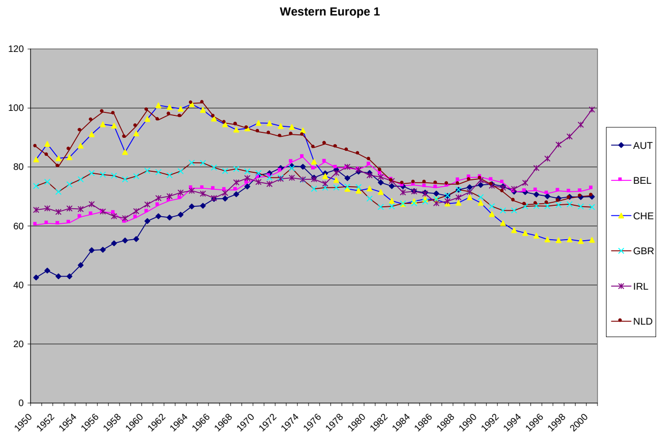
BRB
DOM
JAM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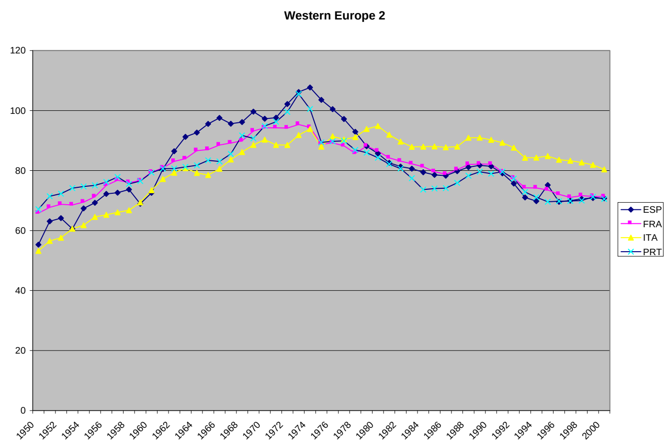
CHE
GBR
IRL
NLD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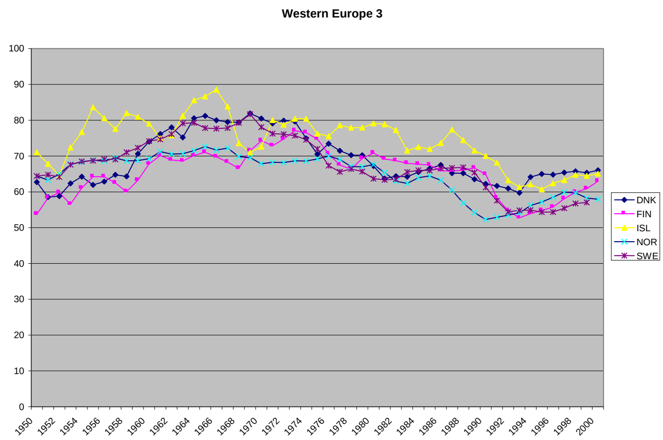
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NOR
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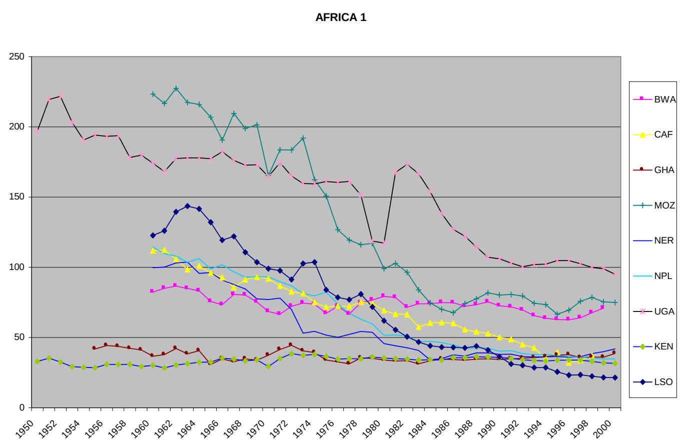
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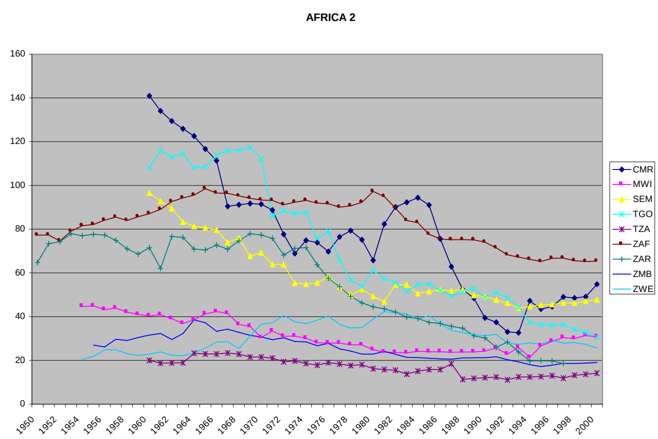
KEN
LSO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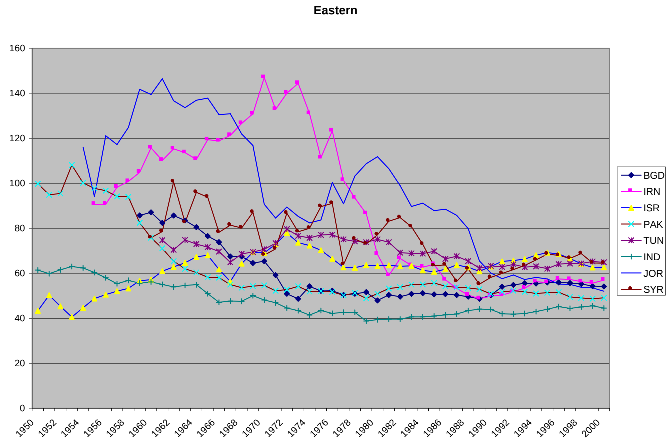
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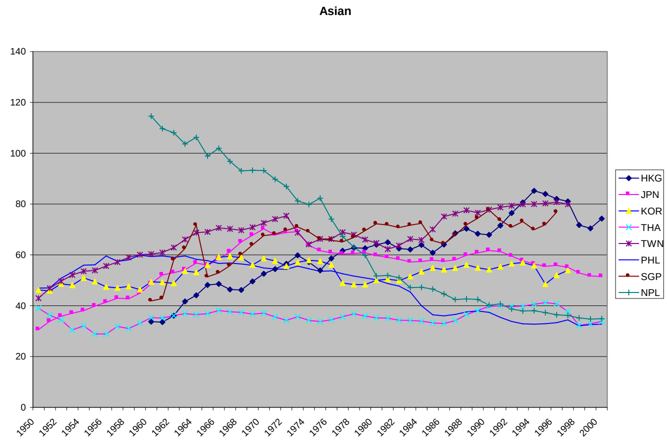
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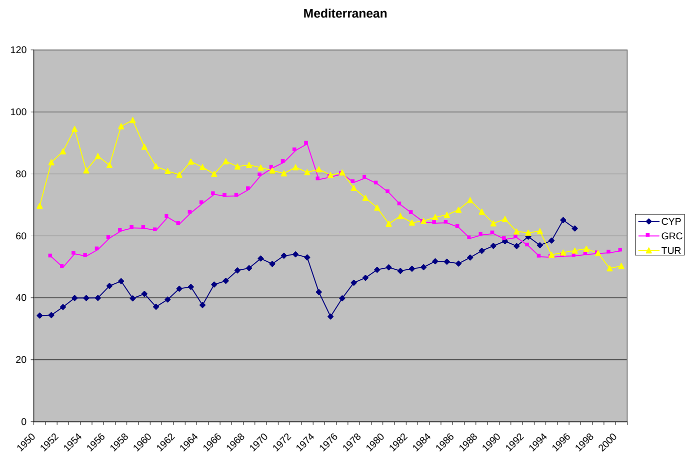
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CYP
GRC
TUR

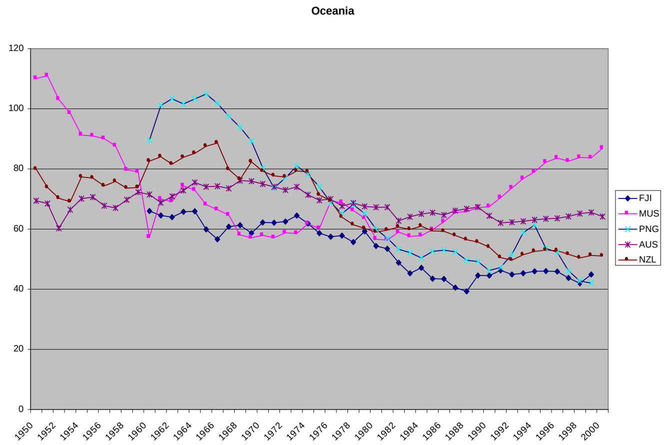
Oceania
FJI
MUS
PNG
AUS
NZL

Table A.2: Year and Type of Break

TABLE 3

	Year of Break by Type					Year of Break by Type				
Country	UP		DOWN		Country	UP		DOWN		
ARG			30(1981)		**MOZ**			13(1974)		
AUT	9(1960)		24(1975)		**MUS**	34(1985)				
BEL	9(1960)		30(1981)		**MWI**	40(1995)		13(1968)		
BOL	10(1961)		17(1968)		**NER**			13(1974)	19(1980)	
BRA			30(1981)	39(1990)	**NLD**			24(1975)		
BRB	25(1986)				**NIC**			19(1970)	28(1979)	37(1988)
CAN	39(1990)		29(1980)		**NOR**			30(1981)		
CHE	24(1974)		40(1991)		**NPL**			15(1976)		
CMR	33(1994)		25(1986)		**NZL**			16(1967)	24(1975)	37(1988)
COL			30(1981)	40(1991)	**PAK**			8(1959)		
CRI			22(1973)	29(1980)	**PAN**			36(1987)		
CYP	14(1965)	36(1987)			**PER**			37(1988)		
DNK	8(1959)		23(1974)		**PHL**			9(1960)	35(1986)	
DOM	7(1959)		23(1975)		**PNG**			5(1966)	34(1995)	
ECU			26(1977)		**PRT**			23(1974)		
ESP	10(1961)		24(1975)		**PRY**			30(1981)	41(1992)	
FIN	39(1990)				**SLV**			16(1967)	29(1980)	
FJI	27(1987)				**SWE**			19(1970)	39(1990)	
FRA			23(1974)		**SYR**			23(1984)		
GBR			23(1974)		**TGO**			10(1971)	16(1977)	32(1993)
GRC			22(1974)		**THA**	8(1959)				
GTM			30(1981)		**TTO**			34(1985)		
HND			29(1980)	42(1993)	**TUN**			10(1971)	27(1988)	
IND			14(1965)		**TUR**			26(1977)	43(1994)	
IRL	8(1959)	43(1994)			**TWN**	34(1985)				
IRN			21(1977)		**TZA**	34(1994)		27(1988)		
ISL			37(1988)		**UGA**			33(1984)		
ITA			23(1974)		**URY**			7(1958)	31(1982)	
JAM			19(1973)	37(1993)	**USA**			22(1973)		
JOR	15(1970)		34(1989)		**VEN**	11(1962)		20(1971)		
JPN			20(1971)	41(1992)	**ZAF**			31(1982)		
KEN			11(1962)		**ZAR**	7(1958)		24(1975)		
KOR	12(1963)		25(1976)		**ZMB**			21(1977)		
LSO			14(1975)		**ZWE**	14(1969)	37(1992)	31(1986)		
MEX			31(1982)							

Table A.3: Possible Causes of Breaks

Countries	Number of Breaks	Dates	Possible Explation	Dates	Possible Explation
ARG	1	1981	Democracy returned 1983;International Interest Rates Shock		
AUS	0				
AUT	2	1960	European Free Trade Association	1975	Oil Shock
BEL	2	1960	European Economic Community	1981	
BGD	0				
BOL	2	1961		1968	Constitution (1967)
BRA	2	1981	International Interest Rates Shock	1990	Constitution 1988
BRB	1	1986	General Election 1986		
BWA	0				
CAF	0				
CAN	2	1980	Oil Shock; April 1982 (Constitutional Action);	1990	1989 US-Canada FTA
CHE	2	1975	Oil Shock	1991	
CHL	0				
CMR	2	1986	1990: Legalized Opposition Parties	1994	Constitution: revision January 1996
COL	2	1981	Oil Shock	1991	Constitution: July de 1991
CRI	2	1973	Oil Shock	1980	International Interest Rates Shock
CYP	2	1965		1987	New constitution for the Turkish Cypriot area passed by referendum on 5 May 1985
DNK	2	1959	European Free Trade Association	1974	Oil Shock
DOM	2	1959		1975	Oil Shock
ECU	1	1977	Oil Shock		
ESP	2	1961		1975	Constitution: December de 1978
FIN	1	1990	European Union		
FJI	1	1987	Democratic rule was interrupted by two military coups in 1987,		
FRA	1	1974	Oil Shock		

Table A.3: Possible Causes of Breaks (cont.)

Countries	Number of Breaks	Dates	Possible Explation	Dates	Possible Explation	Dates	Possible Explation
GBR	1	1974	Oil Shock				
GHA	0						
GRC	1	1974	Democratic elections in 1974 and a referendum created a parliamentary republic and abolished the monarchy; Constitution: June 1975				
GTM	1	1981	Military Coup; Oil/Interest Rate Shock				
GUY	0						
HKG	0						
HND	2	1980	oil shock; international financial crisis	1993			
IND	1	1965	War with Pakistan				
IRL	2	1959		1994	economic reforms & liberalization		
IRN	1	1977	Oil Shock, Islamic Revolution				
ISL	1	1988	inflation; stabilization plan; crisis in the fishing industry				
ISR	0						
ITA	1	1974	European Economic Community				
JAM	2	1973	Oil Shock; domestic violence and dropoff in tourism.	1993	inflation; high public deficit, macroeconomic mismanagement		
JOR	2	1970		1989			
JPN	2	1971	Oil Shock	1992	Real State Bubble; Recession		
KEN	1	1962	Independence and Constitution: December 1963 (from UK);				
KOR	2	1963	Industrial Policy	1976	Oil Shock		
LSO	1	1975	Oil Shock				
MEX	1	1982	International Interest Rates Shock				
MOZ	1	1974	Independence: June 1975				
MUS	1	1985	General Election 1983				
MWI	2	1968	Independence; dictatorship	1995	After three decades of one-party rule, the country held multiparty elections in 1994 under a provisional constitution; Constitution: May 1994		
MYS	0						
NER	2	1974	Oil Shock	1980	International Interest Rates Shock; Oil Shock		
NLD	1	1975	Oil Shock				
NIC	3	1970		1979	Sandinista Guerrilla	1988	New Constitution;
NOR	1	1981					
NPL	1	1976	Oil Shock				
NZL	3	1967	recession	1975	Oil Shock	1988	Constitutional Action 1986 with
PAK	1	1959	Border conflicts with China and India;				
PAN	1	1987	Civil Unrest, Noriega ousted from power 1989				

Table A.3: Possible Causes of Breaks (cont.)

Countries	Number of Breaks	Dates	Possible Explation	Dates	Possible Explation	Dates	Possible Explation
PER	1	1988	Guerrilla Sendero Luminoso				
PHL	2	1960		1986	Constitution: February 1987		
PNG	2	1966	Monetary Union	1995	Financial and Debt Crisis;		
PRT	1	1974	Revolution; Constitution: April 1976				
PRY	2	1981	International Interest Rates Shock	1992			
SEM	0						
SGP	0						
SLV	2	1967		1980	Civil War		
SWE	2	1970		1990	European Union		
SYR	1	1984					
TGO	3	1971	civil unrest	1977	Oil Shock	1993	Constitution July
THA	1	1959					
TTO	1	1985	General Election 1987				
TUN	2	1971		1988	Constitution: June 1959; Main reforms July 1988		
TUR	2	1977	oil shock	1994	Financial Crisis; recession		
TWN	1	1985	trade liberalization				
TZA	2	1988	Constitution: main revision October 1984	1995	Zanzibar is semi-autonomous status and popular opposition have led to two contentious elections since 1995		
UGA	1	1984	guerrilla (1980-85);				
URY	2	1958	terms of trade shock; inflation	1982	International Interest Rates Shock		
USA	1	1974	Oil Shock				
VEN	2	1962	OPEC	1971	Oil Shock; Nationalization		
ZAF	1	1982	New Constitution: 1983				
ZAR	2	1958	independence; terms of trade	1975	Nationalization; restriction to foreingn investiment; civil unrest		
ZMB	1	1977					
ZWE	3	1969	independence; trade-embargo; civil unrest	1986	drought and foreign exchange crisis; violation of properties right	1992	